Docket No. - GMC 0047 PA

CLAIMS

1. A device configured to convert a hydrogenous fuel source to electrical energy, said device comprising:

an electrochemical conversion assembly configured to partition said device into first and second flow field regions;

a first reactant input and a first product output in communication with said first flow field region;

a first diffusion media comprising a porous diffusion media substrate configured to pass multiphase reactants between said first flow field region and said electrochemical conversion assembly;

a second reactant input and a second product output in communication with said second flow field region; and

a second diffusion media comprising a porous diffusion media substrate configured to pass multiphase reactants between said second flow field region and said electrochemical conversion assembly, wherein

said device is configured such that at least one of said first and second diffusion media comprise a region subject to relatively high H_2O concentrations and a region subject to relatively low H_2O concentrations,

a mesoporous layer is carried along at least a portion of a major face of one of said first and second diffusion media substrates and comprises a hydrophilic carbonaceous component and a hydrophobic component, and

said mesoporous layer occupies a substantially greater portion of one of said high H_2O region and said low H2O region relative to the other of said high H_2O region and said low H2O region.

2. A device as claimed in claim 1 wherein said mesoporous layer is substantially confined to one of said high H_2O region and said low H_2O region.

3. A device as claimed in claim 1 wherein said mesoporous layer is configured to enhance H_2O transfer properties of said diffusion media substrate along said portion of said major face occupied by said mesoporous layer.

4. A device as claimed in claim 1 wherein said mesoporous layer occupies a substantially greater portion of said high H_2O region.

5. A device as claimed in claim 1 wherein said mesoporous layer occupies a substantially greater portion of said high H_2O region and is configured to enhance H_2O transfer properties of said diffusion media substrate along said portion of said major face occupied by said mesoporous layer.

6. A device as claimed in claim 1wherein said mesoporous layer is configured to diminish H_2O transfer properties of said diffusion media substrate along said portion of said major face occupied by said mesoporous layer.

7. A device as claimed in claim 6 wherein said mesoporous layer occupies a substantially greater portion of said low H_2O region.

8. A device as claimed in claim 1 wherein said mesoporous layer occupies a substantially greater portion of said low H_2O region and is configured to diminish H_2O transfer properties of said diffusion media substrate along said portion of said major face occupied by said mesoporous layer.

9. A device as claimed in claim 1 wherein:

said electrochemical conversion assembly defines an anode side of said device and a cathode side of said device;

said first reactant input and said first product output are in communication with said anode side of said device;

said second reactant input and said second product output are in communication with said cathode side of said device.

10. A device as claimed in claim 9 wherein:

said mesoporous layer is configured to enhance H_2O transfer properties of said diffusion media substrate along said portion of said major face occupied by said mesoporous layer;

said region subject to relatively high H_2O concentrations is proximate said second product output in communication with said cathode side of said device; and

said mesoporous layer occupies a substantially greater portion of said high H_2O region proximate said second product output.

11. A device as claimed in claim 9 wherein:

said mesoporous layer is configured to enhance H_2O transfer properties of said diffusion media substrate along said portion of said major face occupied by said mesoporous layer;

said region subject to relatively high H_2O concentrations is proximate said first reactant input in communication with said anode side of said device; and

said mesoporous layer occupies a substantially greater portion of said high H_2O region proximate said first reactant input.

12. A device as claimed in claim 9 wherein:

said mesoporous layer is configured to diminish H_2O transfer properties of said diffusion media substrate along said portion of said major face occupied by said mesoporous layer;

said region subject to relatively low H_2O concentrations is proximate said second reactant input in communication with said cathode side of said device; and

said mesoporous layer occupies a substantially greater portion of said low H_2O region proximate said second reactant input.

13. A device as claimed in claim 9 wherein:

said mesoporous layer is configured to diminish H_2O transfer properties of said diffusion media substrate along said portion of said major face occupied by said mesoporous layer;

said region subject to relatively low H_2O concentrations is proximate said first product output in communication with said anode side of said device; and

said mesoporous layer occupies a substantially greater portion of said low H_2O region proximate said first product output.

14. A device as claimed in claim 1 wherein a plurality of said mesoporous layers are carried along respective portions of a major face of one of said first and second diffusion media substrates.

15. A device as claimed in claim 14 wherein:

a mesoporous layer configured to enhance H_2O transfer properties of said diffusion media substrate occupies a substantially greater portion of said high H_2O region; and

a mesoporous layer configured to diminish H_2O transfer properties of said diffusion media substrate occupies a substantially greater portion of said low H_2O region.

16. A device as claimed in claim 1 wherein said mesoporous layer is carried along a reduced thickness portion of said substrate.

17. A device as claimed in claim 16 wherein a difference in thickness of said substrate introduced said reduced thickness portion of said substrate is sufficient to accommodate for an increase in diffusion media thickness introduced by said mesoporous layer.

18. A device as claimed in claim 1 wherein said diffusion media substrate comprises a carbonaceous fibrous matrix.

19. A device as claimed in claim 1 wherein said hydrophobic component of said mesoporous layer comprises a fluorinated polymer.

20. A device as claimed in claim 1 wherein said hydrophilic carbonaceous component of said mesoporous layer is selected from carbon black, graphite, carbon fibers, carbon fullerenes, carbon nanotubes, and combinations thereof.

21. A device as claimed in claim 1 wherein said hydrophilic carbonaceous component comprises a moderate surface area carbon characterized by a surface area of between about 60 m^2/g and about 300 m^2/g and a mean particle size of between about 15 nm and about 70 nm in said high H_20 regions.

22. A device as claimed in claim 1 wherein said hydrophilic carbonaceous component comprises a high surface area carbon characterized by a surface area of above about 750 m^2/g and a mean particle size of less than about 20 nm in said low H_2O regions.

23. A device as claimed in claim 1 wherein said mesoporous layer comprises about 80 wt% of said carbonaceous component in said high H_2O region.

24. A device as claimed in claim 1 wherein said mesoporous layer comprises between about 75 wt% and about 85 wt% of said carbonaceous component in said high H_2O region.

25. A device as claimed in claim 1 wherein said mesoporous layer comprises between about 90 wt% and about 95 w% of said carbonaceous component in said low H_2O region.

26. A device as claimed in claim 1 wherein said mesoporous layer defines a thickness of less than about 20μm in said high H_2O regions.

27. A device as claimed in claim 1 wherein said mesoporous layer defines a thickness of between about 10μm and about 40μm in said low H_2O regions.

28. A device as claimed in claim 1 wherein said mesoporous layer at least partially infiltrates said diffusion media substrate.

29. A device as claimed in claim 1 wherein said mesoporous layer infiltrates said diffusion media substrate to a depth of less than 10μm in said high H2O regions.

30. A device as claimed in claim 1 wherein said mesoporous layer infiltrates said diffusion media substrate to a depth of less than 25μm in said low H2O regions.

31. A device as claimed in claim 1 wherein said device comprises a fuel cell.

32. A device as claimed in claim 31 wherein said device further comprises structure defining a vehicle powered by said fuel cell.

33. A device configured to convert a hydrogenous fuel source to electrical energy, said device comprising:

an electrochemical conversion assembly configured to partition said device into first and second flow field regions;

a first reactant input and a first product output in communication with said first flow field region;

a first diffusion media comprising a porous diffusion media substrate configured to pass multiphase reactants between said first flow field region and said electrochemical conversion assembly;

a second reactant input and a second product output in communication with said second flow field region; and

a second diffusion media comprising a porous diffusion media substrate configured to pass multiphase reactants between said second flow field region and said electrochemical conversion assembly, wherein

said device is configured such that at least one of said first and second diffusion media comprise a region subject to relatively high H_2O concentrations and a region subject to relatively low H_2O concentrations,

a mesoporous layer is carried along at least a portion of a major face of one of said first and second diffusion media substrates and comprises a hydrophilic carbonaceous component and a hydrophobic component,

at least one of said first and second diffusion media substrates comprises a relatively high porosity region and a relatively low porosity region,

said relatively high porosity region of said substrate occupies a substantially greater portion of said high H_2O region and said relatively low porosity region of said substrate occupies a substantially greater portion of said low H_2O region.

34. A device as claimed in claim 33 wherein said relatively high porosity region is characterized by a porosity of up to about 90%.

35. A device as claimed in claim 33 wherein said relatively low porosity region is characterized by a porosity of between about 70% and about 75%.

36. A device as claimed in claim 33 wherein said substrate is characterized by a porosity of above about 70% in said high H_2O regions.

37. A device as claimed in claim 33 wherein said substrate is characterized by a porosity of between about 70% and about 75% in said low H_2O regions.

38. A device as claimed in claim 33 wherein said substrate defines a thickness of between about 100μm and about 300μm in said high H_20 regions.

39. A device as claimed in claim 33 wherein said substrate defines a thickness of between about 190μm and about 300μm in said low H_20 regions.

40. A device as claimed in claim 33 wherein said substrate is characterized by a mean pore size of above about 20μm in said high H_20 regions.

41. A device as claimed in claim 33 wherein said substrate is characterized by a mean pore size of less than about 25μm in said low H_20 regions.

42. A device configured to convert a hydrogenous fuel source to electrical energy, said device comprising:

an electrochemical conversion assembly configured to partition said device into first and second flow field regions;

a first reactant input and a first product output in communication with said first flow field region;

a first diffusion media comprising a porous diffusion media substrate configured to pass multiphase reactants between said first flow field region and said electrochemical conversion assembly;

a second reactant input and a second product output in communication with said second flow field region; and

a second diffusion media comprising a porous diffusion media substrate configured to pass multiphase reactants between said second flow field region and said electrochemical conversion assembly, wherein

said device is configured such that at least one of said first and second diffusion media comprise a region subject to relatively high H_2O concentrations and a region subject to relatively low H_2O concentrations,

a mesoporous layer is carried along at least a portion of a major face of one of said first and second diffusion media substrates and comprises a hydrophilic carbonaceous component and a hydrophobic component,

said mesoporous layer occupies substantial portions of said high H_2O region and said low H2O region,

said mesoporous layer comprises a region of increased porosity relative to a remaining portion of said mesoporous layer,

said region of increased porosity of said mesoporous layer occupies a substantially greater portion of said high H_2O region relative to said low H2O region, and

said remaining portion of said mesoporous layer occupies a substantially greater portion of said low H_2O region relative to said high H2O region.

43. A device as claimed in claim 42 wherein said region of increased porosity of said mesoporous layer is defined by a plurality of megapores characterized by a pore size of between about 100μm and about 500μm.